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Neutrino cooling and spin-down of rapidly rotating compact stars

PRASHANTH JAIKUMAR, California State University Long Beach — Gravitational radiation destabilizes the r-mode in young rapidly rotating compact stars, spinning them down to angular frequencies $\Omega \sim 0.1\Omega_{\rm Kepler}$ soon after their birth in a Supernova. Such quasi-normal pulsation modes are typically expected in the aftermath of a supernova or a sudden rearrangement of the neutron star crust or core. We point out that the r-mode perturbation also impacts the neutrino cooling in hot compact stars via processes that restore weak equilibrium. Since the viscous damping timescale is very sensitive to the temperature of the fluid, thermal evolution of the star affects r-mode evolution. We illustrate this fact with a simple model of spin-down due to gravitational wave emission in compact stars composed entirely of three-flavor degenerate quark matter. Neutrino cooling of such matter is quantified. Our results imply that a consistent treatment of thermal and spin-frequency evolution of a young and hot compact star is a requisite in estimating the persistence of gravitational waves from such a source.

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